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Pest Management Grants Final Report
Department Of Pesticide Regulation
Agreement No. 98-0328

PESTICIDE RISK REDUCTION IN CALIFORNIA PRUNES

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III. Executive Summary

PESTICIDE RISK REDUCTION IN CALIFORNIA PRUNES is part of the Integrated Prune Farming Practices (IPFP) Program. IPFP serves as an umbrella project for several projects relating to reduced-risk of pesticides in prune production including the CalEPA/DPR/PMA Project. Project objectives are:

1) Develop and implement replacement pest management systems impacted by the Food Quality Protection Act (FQPA).
2) Develop and implement low environmental risk pest management and cultural programs that reduce surface and ground water contamination by organophosphates (e.g. Diazinon), herbicides, and fertilizers (e.g. Nitrate leaching).
3) Develop and implement low environmental risk pest management programs that reduce human exposure to pesticides (e.g. farm workers and urban environments).
4) Evaluate ground covers and cover crops for their ability to increase biological control of pest organisms and reduce groundwater contamination by toxic pesticides and fertilizers.
5) Develop and implement strategies to promote irrigation efficiency and optimize water use.
6) Develop and implement low risk pest management strategies that minimize pest resistance to pesticides.

During 1999 and 2000, dormant applications of Diazinon (OP insecticide) were eliminated in all demonstration/research sites. Asana was applied in the conventional blocks and if a dormant treatment was needed in the reduced risk block, oil was applied. In-season pesticide applications were based on pest monitoring protocols. **The trend of Diazinon use from 1990-1999 shows a reduction of approximately half the amount used in 1992 or 45,000 pounds.** Twelve separate monitoring protocols were developed for monitoring prune pest through the year. These protocols were modified for PCAs to use on 10 sites in 2000. If pest control was needed softer pesticides were used, such as Bt. Covercrops have been established in 12 different prune orchards. Based on this year's pest monitoring and need of pesticide treatment thresholds, the Prune Industry could have saved approximately $1,738,000 during 2000. Plant nutrient applications, fertilizations, were based on plant and water analysis and in most cases less than what the grower would have used. Some locations had enough nitrates in the well water to significantly reduce the cost of nitrogen applied to the prune trees. Irrigation water was significantly reduced in most of the IPFP sites and has in fact been the surprise of the IPFP Program relative to potential benefit and response from growers. Over 24 educational meetings were held in 2000 with an audience of over 1,100.

Agreement No. 98-0328 in part supported the IPFP Program. A great deal has been accomplished by the prune industry after the first two years toward pesticide risk reduction in California Prunes. The reduction in use of Diazinon by half by the Prune Industry over the last several years has been in part by the IPFP Program. We are aware that fully reaching the stated objectives will take multiple years. The prune industry is committed to accomplishing the objectives.

IV. PROGRAM

Introduction:

Annually, California produces about 200,000 tons of dried prunes valued at approximately $200 million dollars from 81,000 bearing acres. This represents approximately 99% of the US and 70% of world prune production. The California Prune Board (CPB) that administers the State Marketing Order represents California's fourteen hundred prune growers and twenty-one packers.

Although California prune growers contend with a variety of insect, disease, nematode, and weed pests, the number of severe pests is relatively few compared to other stone and pome fruits. Often prunes can be grown with minimal fertilizer and few pesticides. The CPB has been committed to Integrated Pest Management (IPM) and reducing high environmental risk inputs to prune culture. Their financial support has developed a significant knowledge base allowing growers to move toward reduced-risk pest management systems.

The focus of the "**PESTICIDE RISK REDUCTION IN CALIFORNIA PRUNES**" project is to provide California prune growers with an alternative economic, low environmental risk pest management and cultural program for growing prunes. Prune industry-wide implementation of the reduced risk program will be the ultimate goal of this project.

The process of implementing IPM technology for prunes began 3 years ago with the Biological Prune Production (BPS) and the Environmentally Sound Prune System (ESPS) projects. The current project compliments existing and past CalEPA/Department of Pesticide Regulation (DPR) projects and grants from UC/Sustainable Agricultural Research and Education Program (SAREP), USDA/Cooperative State Research, Education and Extension Service (CSREES) and USDA/Natural Resources Conservation Service (NRCS) to the CPB and projects supported by the CPB to enhance the implementation effort.

Work plan objectives are to:

1) Develop and implement replacement pest management systems impacted by the Food Quality Protection Act (FQPA).
2) Develop and implement low environmental risk pest management and cultural programs that reduce surface and ground water contamination by organophosphates (e.g. Diazinon), herbicides, and fertilizers (e.g. Nitrate leaching).
3) Develop and implement low environmental risk pest management programs that reduce human exposure to pesticides (e.g. farm workers and urban environments).
4) Evaluate ground covers and cover crops for their ability to increase biological control of pest organisms and reduce groundwater contamination by toxic pesticides and fertilizers.
5) Develop and implement strategies to promote irrigation efficiency and optimize water use.
6) Develop and implement low risk pest management strategies that minimize pest resistance to pesticides.

Demonstration and implementation of reduced risk pest and cultural management programs in prunes will demonstrate feasibility of growing stone fruits with much less reliance on toxic pesticides. This is especially important for almonds, cling peaches and fresh stone fruits where similar pest complexes occur. Grape growers near prune orchards will also benefit because prunes act as a reservoir for grape leafhopper parasites.

Materials and Methods:

IPFP has been built around "Pest Management Evaluation for California Prunes". A Management Team, see Appendix, was established in June 1998 to develop and guide the Integrated Prune Farming Practices (IPFP) Program. At the onset, BPS and ESPS projects were combined to form the core IPFP Program and then more demonstration/research sites added so that all sites in IPFP were replicates containing conventional farming practices, reduced risk practices and a control or untreated check area to validate certain IPFP protocols.

Scope and operation: The number of field plots was determined by total support money available from the various funding sources. All prune growing areas in California are well represented with IPFP plots; 33 prune growers representing approximately 11% of the current bearing prune acreage in California.

There are currently twelve protocols being used to monitor various prune pests and one for monitoring tree-water status. Field "scouts"; weekly monitor each plot (conventional, reduced risk, and check) for insects, diseases, and tree-water status per appropriate protocol. The data are recorded and during the growing season each IPFP grower receives weekly monitoring results and results of seasonal leaf tissue and water analyses. Reduced risk pest management and irrigation scheduling recommendations are made for the reduced risk plots per the protocol directive. A copy of the protocols is available upon request but not included in this report. Leaf samples and irrigation water are sampled in season as a basis for reduced risk fertilizer recommendations for those plots Commercial yield and quality are measured from each plot in each location through the P-1 grade sheet provided by USDA inspection upon crop delivery. Note the reduced risk protocols change as we learn more about reduced risk management programs. The perfect protocol is one where a PCA could easily use it for monitoring.

Education: A key component of the project is education, following the Biologically Integrated Orchard Systems (BIOS) model of timely, interactive field meetings and demonstrations that encourage grower implementation of IPFP. Field days are held at various PMA demonstration and satellite orchards throughout the season to view various operations, discuss results, and/or to demonstrate pest monitoring and other cultural monitoring techniques (e.g. use of degree-days, traps, beating trays, cardboard bands and presence/absence leaf sampling for estimating populations of beneficial insects, leafrollers, PTB, San Jose scale and/or mites, use of a pressure chamber as a tool for irrigation scheduling and tissue sampling to determine optimum nutrient levels). The local University of California Cooperative Extension farm advisor and the BPS coordinator are responsible for planning and conducting meetings. The California Prune Board also participates in IPFP outreach. A quarterly newsletter, annual report, industry meetings, and Internet access (web site: http://agresearch.nu/ipfp.htm is made available to growers.

Evaluating progress: During winter of '98/'99, following the 1st year of the project, a grower survey was conducted to establish current pest control methods and materials. Growers' pesticide use data will be reviewed through CalEPA/DPR/Pesticide Use Reports periodically during this project to see how pest control techniques changed.

Satellite Projects:
Projects need to be researched before being demonstrated or adopted on a wide scale. In previous years, this project supported research on:

1) Alternate year dormant spray program,
2) A predictive model for forecasting scab off-grade at harvest,
3) Aphid control using soft chemicals,
4) Mow and throw technique of mowing cover crop, using the residue as mulch for weed control and the use of rice straw (ag-waste) as mulch for weed control.
5) Developing monitoring techniques to replace the prophylactic use of Bt

This year, the project supported research on:

1) Biological control of Mealy Plum Aphids using <u>*Harmonia axyridis*</u> Lady Beetles.
2) Pesticide efficacy trial using 2 types of oil and 1 type of pesticide for aphid control.
3) Alternate year dormant insecticide program evaluation.
4) A review of the literature of aphid control using oil.
5) A new aphid infestation predicting model.
6) A project using sticky traps and wet traps to catch fall returning aphids, and also a project using early defoliation to determine if this will help control aphid populations in the spring, have both begun.

Results/accomplishments:

A. On-farm demonstrations of alternative farming and pest control systems.

- **<u>Significantly reduced pesticide use in prunes by alternative pest management strategies:</u>** In the 33 locations, dormant organophosphate (OP) sprays were eliminated in the IPFP and control plots and "soft" treatments, if needed, applied according to in-season monitoring. High environmental risk pesticide use has been significantly reduced in our plots. We will validate and quantify the reduction with DPR/Pesticide Data when available and resurvey participating growers.

  The "Pest Management Evaluation for California Prunes" (citation) was revised this past year. It received further revision to fit the USDA Crop Profiles. The "Crop Profile for California Prunes"can be seen at: <u>http://pestdata.ncsu.edu/cropprofiles/Detail.CFM?FactSheets__RecordID=66</u>.

- **<u>Outreach:</u>**
    - o We doubled IPFP sites to 33 throughout prune production areas of California.
    - o Four Management Team meetings were held, (minutes of meetings included in previous quarterly reports).
    - o Four IPFP Newsletters were sent to all prune growers.
    - o A web page for prune research was put online: http://fruitsandnuts.ucdavis.edu/prune.
    - o Used a "chat room" format to effectively communicate with the 3 head field technicians and the project leader.
    - o An e-mail list server was created to aid communications with all participants of the project.
    - o Twenty-four IPFP meetings were in 2000.

- **Validated and implemented reduced risk management of peach twig borer (PTB) and other lepidopterous pests by using *<u>Bacillus thuringiensis (Bt)</u>* and other less toxic materials:** PTB monitoring protocols were evaluated during the season and were modified to help us make pest management decisions. The 33 different locations have provided data to evaluate this protocol. There was concern that oblique-banded leafroller (OBLR) could become a secondary pest but it has not materialized to date.

- **Validated and implemented monitoring techniques for prune rust, brown rot, mites, aphids, scale insects and lepidopterous pests in prunes:** As stated, 33 orchards, with essentially three monitoring sites at each orchard (conventional, reduced risk and control) have provided data for analyses in the next several months. Again this year, several locations had significant aphid populations. These data will be used to improve monitoring and aphid pest control recommendations.

- **Demonstrated use of covercrops for: mow and blow weed control, for increased soil health, biodiversity for beneficial organisms, reduced pesticide run-off, and provide habitat for wildlife protection:** Covercrops have been established in 9 different prune orchards; we will monitor their effect on prune orchards including soil health and biodiversity of beneficial organisms. In cooperation with Frank Zalom, UC Davis, one of the covercrop plots is being used to measure pesticide runoff from dormant OP applications. Additionally, two shrub demonstrations were established to be used for a filter/hedgerow and another covercrop plot was used to develop baseline data on birds with the idea of using covercrops in the prune orchard and a neighboring bird habitat.

- **Demonstrated and implemented optimum irrigation scheduling techniques to prevent excessive irrigations that increase runoff and ground water contamination:** Pressure chamber readings were taken throughout the growing season to measure tree-water status. Irrigation recommendations were made based upon pressure chamber readings. Preliminary observations indicate one or more irrigations can be eliminated without adverse effect on crop yield or quality by scheduling irrigations based on tree-water status.

B. Dormant Treatment Decision Guide.

Situation:

The annual dormant spray has been widely used because growers have been taught for many years that this is the most efficacious spray they can apply. First, it kills a number of pests (San Jose Scale, peach twig borer, European Red Mite, mealy plum and leaf curl plum aphid and secondly, it is least harmful to beneficials. Recently, the dormant spray has been found to pollute natural resources, suggesting dormant insecticide sprays are being over used. A monitoring technique was needed to help growers decide if a dormant insecticide treatment was required.

Demonstration:

A fall leaf and dormant fruit spur sample were collected from 40 trees in each section of each orchard to determine their utility in making dormant treatment decisions for prune aphids, SJS and ERM. Treatment levels have been tentatively established (see Table 1). If 7.5-15 % of the trees are predicted to have aphids a single delayed dormant oil treatment is applied. If more that 15% of the sample trees have aphids, multiple oil treatments or a dormant insecticide and oil treatment may be needed. If over 10 percent of the spurs have SJS or ERM a delayed dormant oil treatment is advised.

Table 1. Thresholds for Prune Aphids.

Level of Aphid Infestation	# of Trees w/ Aphids Out of 40	% Trees Infested	Expected Spring Aphids
Level 1	0 - 2	0 - 5 %	Very Few
Level 2	3 - 6	7.5 - 15 %	Some
Level 3	7 or more	Over 15%	Wide Spread

Evaluation:

Dormant spur monitoring can assess SJS and ERM populations for treatment recommendation. Treatment thresholds for this pest are subjective because no data exists as to levels of SJS or ERM prune trees can tolerate. Fall aphid monitoring is moderately accurate in predicting the presence of aphids in the spring with 80% reliability (see Fig. 1), but only 67% accurate in predicting the level of spring aphid populations (see Fig. 2).

Fig. 1

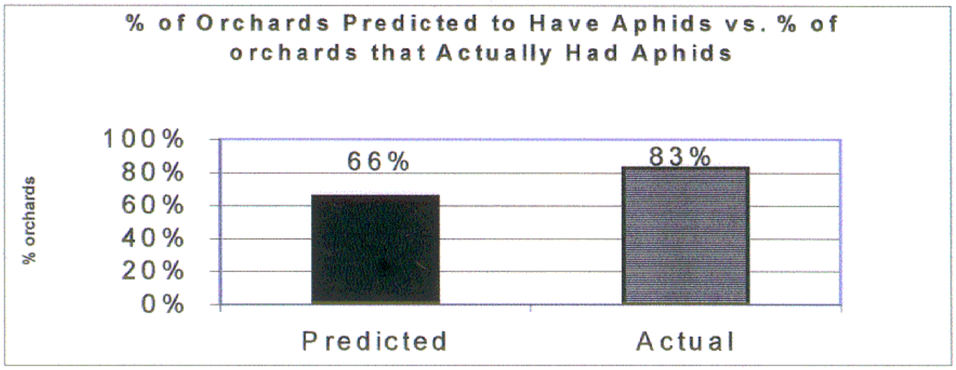

% of Orchards Predicted to Have Aphids vs. % of orchards that Actually Had Aphids
% orchards
100%
80%
60%
40%
20%
0%
66%
83%
Predicted
Actual

Fig. 2

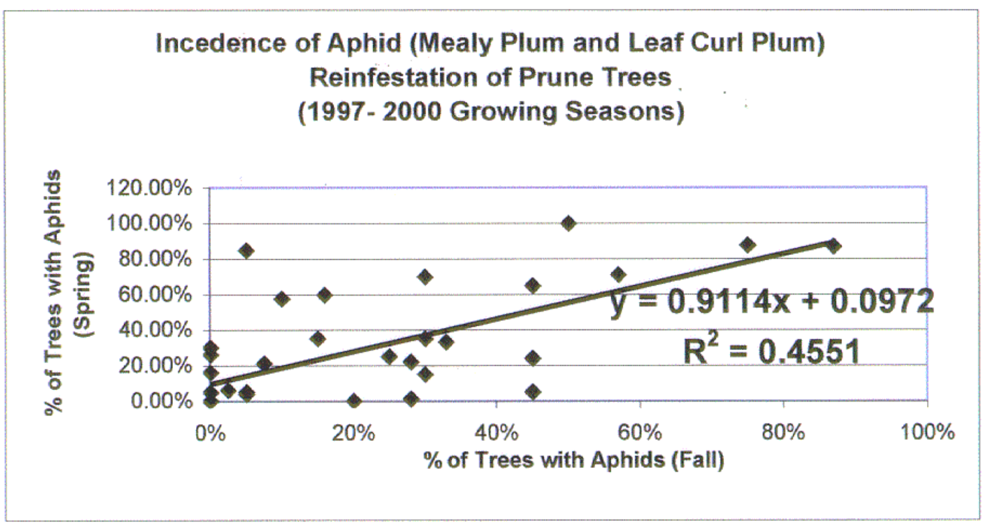

Incedence of Aphid (Mealy Plum and Leaf Curl Plum)
Reinfestation of Prune Trees
(1997- 2000 Growing Seasons)
% of Trees with Aphids (Spring)
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
y = 0.9114x + 0.0972
R2 = 0.4551
0%
20%
40%
60%
80%
100%
% of Trees with Aphids (Fall)

Table 2: "Reduced Risk Dormant Treatment Decision Guide"

Aphids at Level:			Mites and/or Scale Above Threshold?	Treatment Recommendation
Level 1	Level 2	Level 3		
X			No	Nothing
X			Yes	Dormant oil*
	X		No	Oil at bloom*
	X		Yes	Delayed dormant oil* or oil at bloom*
		X	No	Oil at bloom* + in-season
		X	Yes	Delayed dormant oil or oil at bloom* + in-season

* oil applications near Captan and Bravo may cause phytotoxicity.

Conclusion:

The aphid monitoring decision guide is not as accurate as hoped and needs further refinement. By using the decision guide, 54% of the orchards did not have an aphid problem and did not need a dormant insecticide and/or oil treatment. Forty six percent were predicted to have aphids and required a treatment of some kind and SJS and/or ERM populations were found to be at treatable levels in 23 % of the orchards (see Table 3).

This guide predicted a need for dormant insecticide and oil treatment to control aphids and/or SJS and /or ERM in 62 percent of the orchards; 38 percent of the orchards would not benefit from a dormant treatment (see Table 3). If one forecasts not treating 38 percent of California's bearing prune orchards with a dormant insecticide/oil spray, approximately $850,000 would have been saved. Pesticide use and pollution of our natural resources would be reduced. Clearly a dormant treatment guide such as this would be very useful for making dormant treatment decisions. However, the current guide needs more extensive validation more prune aphid research is needed.

Table 3: Percent of Comparison Blocks that fell into each of the Six Treatment Categories

Aphids at Level:			Mites and/or Scale Above Threshold?	% of Orchards in Each Category	
Level 1	Level 2	Level 3		Reduced Risk Treatment Recommended	Conventional Dormant Insecticide and Oil Treatment Recommended
X			No	38.5	0
X			Yes	15.4	0
	X		No	7.7	0
	X		Yes	0	0
		X	No	30.8	30.8
		X	Yes	7.7	7.7

C. Pheromone Traps to Aid with Treatment Decisions

Situation:

Pheromone traps for PTB and SJS have long been available for use but are not used by prune growers for treatment decisions. Instead, they are usually used to help determine treatment timing. We evaluated use of these pheromone traps for treatment decisions. SJS traps could also be used to assess presence of beneficial insects.

Demonstration:

PTB pheromone traps were monitored throughout the season and SJS pheromone traps during spring. Population activity was documented for use in timing treatments. Correlations were established between insect catch and fruit damage and quantity of beneficial scale insects documented in each orchard with the SJS traps. For each of the 13 comparison sites and 11 demonstration sites 1000 fruit were examined per block near harvest for evidence of SJS or PTB larvae or damage.

Evaluation:

Total PTB moth catch in the reduced risk, conventional, and check blocks were not significantly different. An example of seasonal trap catches and generations using the reduced risk plot are presented in Fig. 3. PTB trap catches were correlated (R=. 76) to the percentage of fruit with worm damage at harvest (See Fig, 4). However fruit damage was quite low and not considered economic for the dried prune industry.

Fig 3. PTB Pheromone Trap Catches in Yuba County Orchard Showing the Three Generations

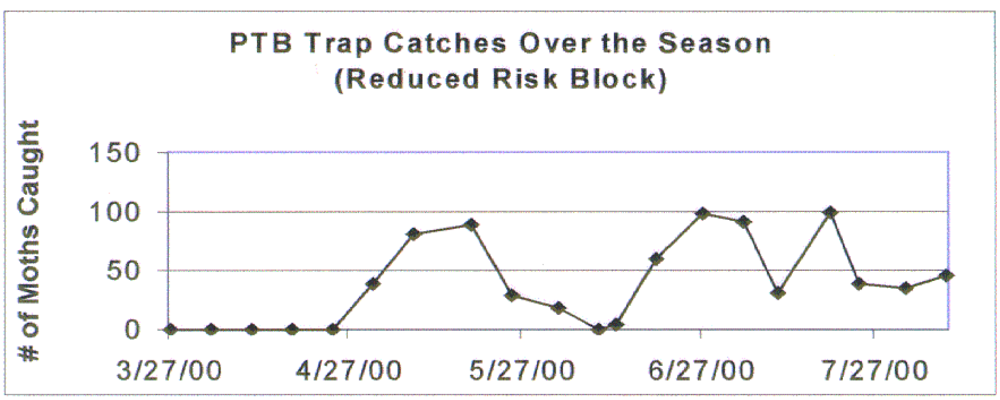
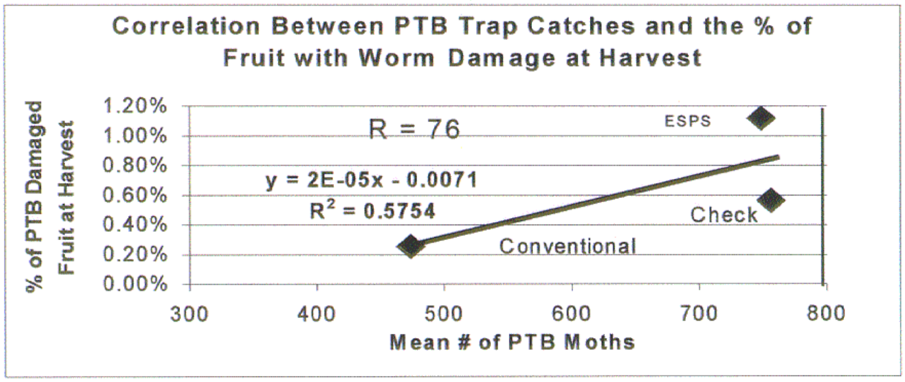
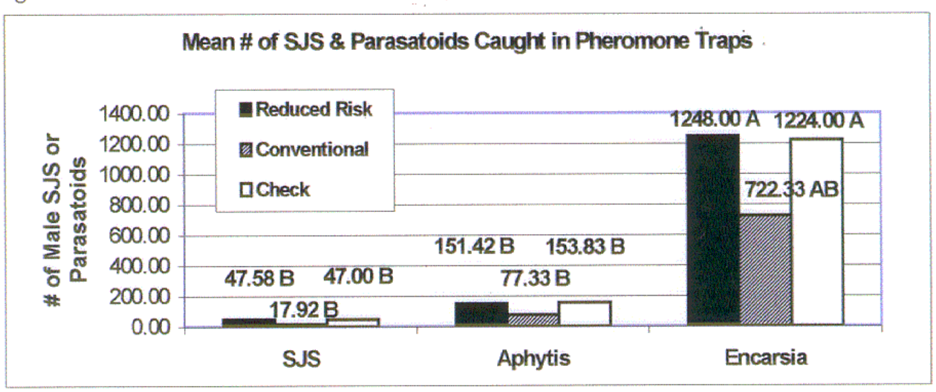


Fig. 4.



SJS pheromone traps were used to monitor SJS and two beneficial parasitoids, _Aphitis melinus_ and _Encarsia_ (Prospatella spp) that attack SJS. No significant differences in pheromone trap catches were found for male SJS between the conventional, reduced-risk, and check blocks. Differences in species of parasitoids caught did occur. _Encarsia_ *(Prospatella)* was caught in significantly larger numbers in the reduced risk and check blocks than in the conventional. No differences in _Aphitis melinus_ occurred in either plot (see Fig. 5).

Fig. 5.



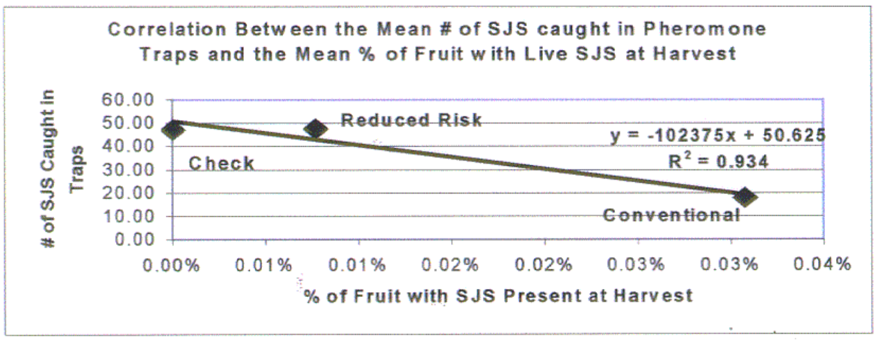
Treatment means that are not followed by a common letter are significantly different from each other at the 5% level according to Duncan's Multiple Range Test for Mean Separation. The plots had significantly less fruit with SJS compared to the conventional plots. The reduced risk plots were intermediate but not significantly different from either check or the conventional. No significant differences occurred in terms of parasitized SJS (See Table 4). There was a strong negative correlation (R=. 96) between the number of male SJS caught in pheromone traps and the percentage of fruit with live SJS present at harvest (See Fig. 6).

Table 4. Mean % Fruit w/ SJS or Parasitized SJS Present at Harvest (All Sites)

TREATMENT	% Fruit w/ SJS	% Fruit w/ Parasitized Scale
REDUCED RISK	.01 ab	0.03
CONVENTIONAL	.03 a	0
CHECK	0 b	0.02

Treatment means not followed by a common letter are significantly different from each other at the 5% level according to Duncan's Multiple Range Test for Mean Separation

Fig 6.



Conclusion:

In-season PTB pheromone trap catches for reduced risk, conventional, and check plots were not significantly different. This suggests application of a dormant treatment has little influence on adult male PTB flight Total male trap catch for the season was moderately correlated with fruit damage indicating that high trap catches may indicate need for an insecticide treatment. Fruit damage reached 1.25 percent. No significant differences in pheromone trap catches were found for male SJS in conventional, reduced-risk, and check blocks. This suggests that, the dormant insecticide and oil treatment is keeping SJS population low in the conventional blocks. , More parasitoids were caught in the reduced risk and check blocks. In these blocks parasitoids are apparently keeping the SJS populations low levels.

Fruit damage from SJS was insignificant at all sites. Based on harvest fruit evaluation, untreated check blocks had significantly fewer fruit with SJS present when compared to conventional blocks. The reduced risk blocks were intermediate but not significantly so. No significant differences occurred in parasitized SJS. The negative correlation indicates that male SJS traps are not useful in predicting fruit damage at harvest at these population levels. Higher population levels may give different results. The traps are useful in documenting populations of beneficial insects.

Pheromone trapping for PTB and SJS provides growers with useful information for treatment timing only by establishing a biofix. In the case of SJS, the presence of scale parasites can be determined. PTB and SJS traps provide little information on estimating potential damage from these two pests.

D. Field Monitoring for Presence of Lepidopterous Pests

Situation:
Presence of lepidopterous worm pests, (PTB) and leafrollers (LR), in a prune orchard often prompts growers to apply an insecticide treatment without knowing what worms are involved or what level can be tolerated without economic damage. Determining economic treatment thresholds for lepidopterous worms in a prune orchard would guide treatment needs.

Demonstration:
Visual inspections of 80 trees/ plot/week were made to determine presence and abundance of PTB and LR larvae/larval damage in spring. If more than 25 percent of the trees had larvae present a treatment of *Bt* was recommended. During summer, 1200 fruit were examined from 80 trees for presence of larvae/larval damage. If more than 2 percent of the fruit had larvae/larval damage a *Bt* treatment was recommended.

For each of the 13 comparison sites and 11 demonstration sites, 1,000 fruit per plot were examined for presence of larval damage just prior to harvest.

Evaluation:
There were no significant differences between Reduced Risk, Conventional, and Check plots in terms of trees or fruit with larvae/ larval damage during the season (See Table 5). One grower did exceed the treatment threshold for fruit with larvae/damage (4 percent) in the reduced risk block but decided not to treat.

There was very little fruit damage at harvest due to PTB or LR. Final evaluation near harvest also indicated very low damage with no significant differences between plots (See Table 6).

The best correlations between larvae or larval damage in season and harvest damage were between the percent of trees with damage in the spring (See Fig. 7) and the percent of fruit with larvae present (See Fig. 8). Correlations were 80 and 84 percent respectively.

Table 5. Mean % of Trees and Fruit with Larvae and/or Larvae Damage (in-season)

TREATMENT	% Trees w/ Worm Damage	Fruit with Larva and/or Damage
REDUCED RISK	5.45	.40
CONVENTIONAL	3.83	.18
CHECK	4.09	.83

Treatment means not followed by a common letter are significantly different at the 5 % level according to Duncan's Multiple Range Test for Mean Separation.

Table 6. Mean % Fruit w/ Larvae or Damage Present (Final Evaluation)

TREATMENT	% Worm Damage
REDUCED RISK	1.3
CONVENTIONAL	0.5
CHECK	1.1

Treatment means not followed by a common letter are significantly different at the 5 % level according to Duncan's Multiple Range Test for Mean Separation.

Fig. 7.

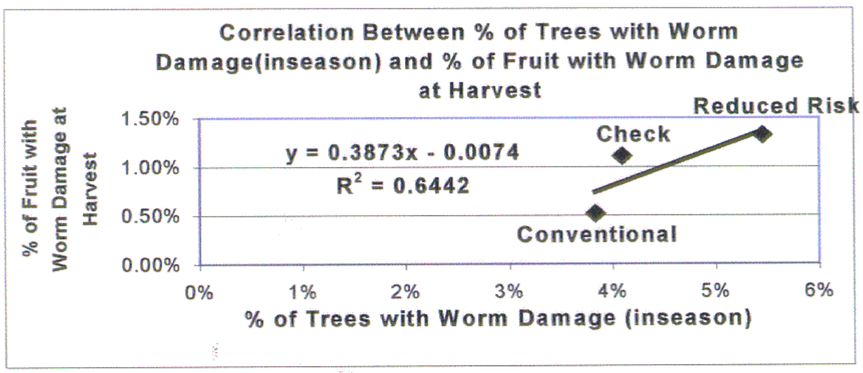
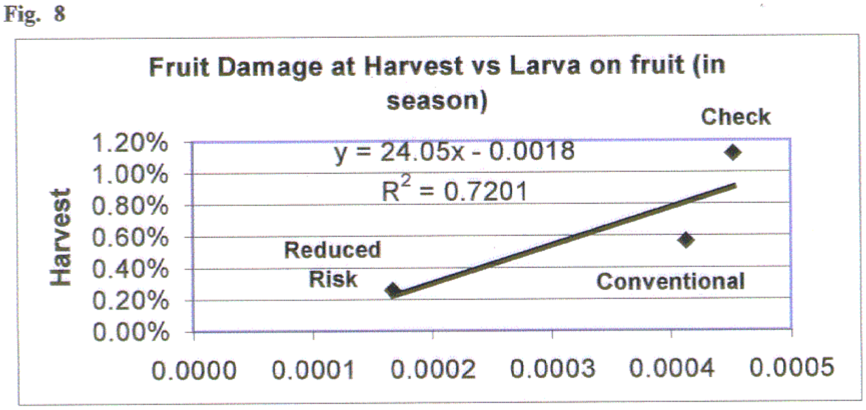


Fig. 8



Conclusion:

None of the plots had a significant number of trees or fruit with larvae/larval damage during the season or at harvest. Similar results were reported in 1999. The final evaluation, just prior to harvest, indicated a good correlation exists between trees with larval damage in the spring and fruit with larval damage at harvest. A better correlation resulted between "in-season" larvae on the fruit and harvest fruit damage. This indicates tree monitoring in spring and fruit monitoring in summer may be useful in predicting end of season damage. The reduced risk blocks averaged 1.5 percent fruit with larval damage, which is believed to be sub-economic.

E. Spring Prune Aphid Monitoring

Situation:
Without a dormant insecticide/oil treatment, Mealy Plum aphid (MPA) and Leaf Curl Plum aphid (LCPA) outbreaks pose a severe risk. A method to determine if aphid populations are present and a potential risk for "in-season" treatment is needed.

Demonstration:
Beginning in April, a random sample of 80 trees per plot was monitored weekly to determine presence of LCPA and MPA. If more than 10 percent of the trees were infested with aphids, a treatment was recommended. Treatments ranged from oil treatment to suppress aphids, to insecticide treatment to eliminate them.

Evaluation:
After following the dormant treatment recommendation based on the "Reduced Risk Dormant Treatment Decision Guide", 15.4 percent of the reduced risk blocks in the comparison orchards exceeded the treatment threshold for LCPA. These orchards are located in Glenn and Tehama Counties and 23.1 percent, located in Sutter, Glenn and Butte Counties, exceeded the threshold for MPA. These orchards were. No conventional blocks, which received a dormant insecticide and oil treatment, exceeded the springtime aphid threshold (See Table 7).

Thirty six percent of the demonstration orchards exceeded the treatment threshold for MPA and thirty-six exceeded the threshold for LCPA (See Table 7). These demonstration orchards were not available to be evaluated in the fall and no dormant treatments were made in these orchards.

During the final evaluations just prior to harvest, 40 fruit from each of up to 25 trees which had been infested by prune aphids were compared with 40 fruit from each of up to 25 trees from trees that had not been infested by aphids (e.g. if only 10 trees in the orchard had aphids, then fruit from only 10 trees that did not have aphids would also be sampled and evaluated). Trees with aphids present had significantly higher levels of "side cracks" (See Fig. 9) and "end cracks" (See Fig. 10).

Table 7. Percent of sites with a treatment recommended during the growing season

% of Sites with a Treatment Recommended					
	MPA		LCPA		Total
	Oil	Insecticide	Oil	Insecticide	
Reduced Risk	7.7	15.4	0	15.4	38.5
Conventional	0	0	0	0	0
Check	n/a	n/a	n/a	n/a	n/a
Demonstration	27.3	9.1	18.2	18.2	72.8

Fig 9.

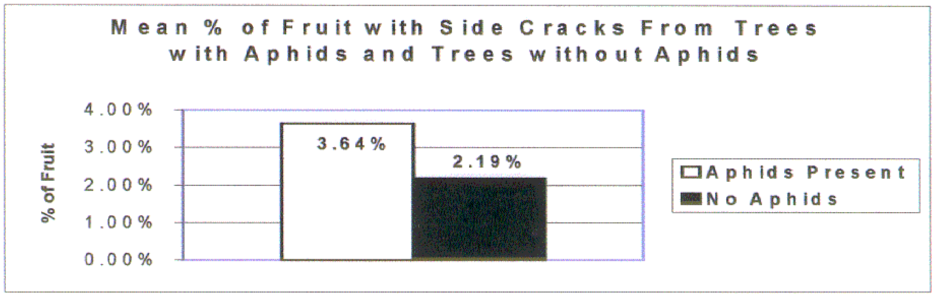
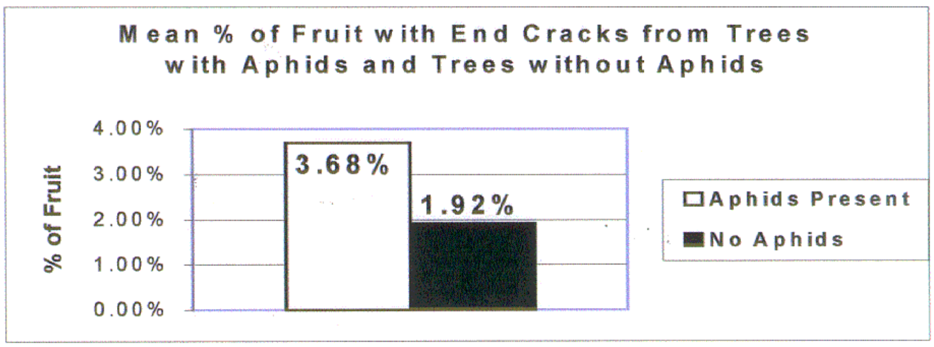


Fig. 10.



Conclusion:
The 80 tree/plot sample for presence of aphids was a good indication of when and if treatment was needed. The 10 percent treatment threshold appears to be fairly accurate. Forty two percent of all of the orchards (Reduced Risk plots within comparison and demonstration orchards) needed an in-season insecticide treatment for aphids. None of the Comparison orchard's conventional blocks, which received a dormant spray, needed in-season treatment. According to this information, an in-season aphid spray would cost growers $ 672,000. Harvest evaluations verified previous information that prune aphids cause fruit cracks.

F. Prune Rust Monitoring and Treatment Timing Recommendations:

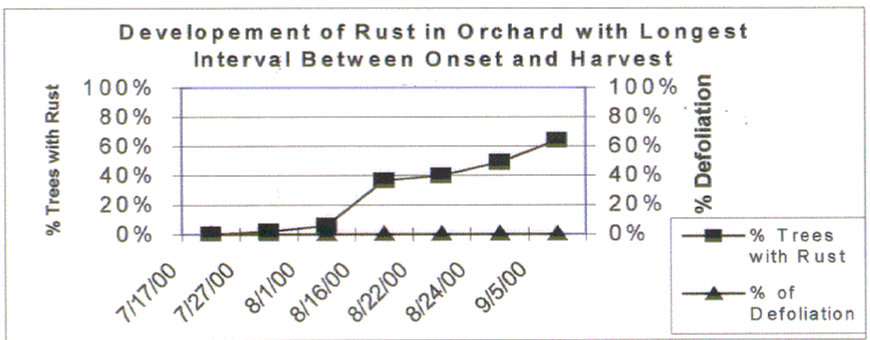
Situation:
Prune rust is the most common disease pest treated during the growing season. Growers currently had no way of monitoring for prune rust and simply applied one or more rust treatments (wettable sulfur) in May, June and or July following rain. Previous research has shown that rust treatments applied close to the onset of rust infection are most beneficial and provides protection for about two weeks. Although pre-harvest defoliation from rust has been

reported to result in reduced fruit dry away and other fruit damage, Teviotdale and Sibbett have shown that post harvest defoliation from rust has no influence on fruit quality or productivity. Further in 1997 Olson, Krueger, and Teviotdale reported appearance of rust infection on leaves has no influence on fruit soluble solids, dry away, and size.

Demonstration:
Monitoring started May 1st and continued to harvest. Forty trees per plot were monitored each week in the Sacramento Valley and every other week in the San Joaquin Valley for the first signs of rust. Once rust was detected, a treatment was recommended. After a rust treatment was applied, and continued monitoring indicates additional increase in rust, additional treatments would be recommended.

Evaluation:
Rust started showing up in mid-July. Seventy-seven percent of comparison orchards and fifty-four percent of demonstration orchards had rust this year. All orchards that had rust were treated. One orchard was treated twice for prune rust. A determination of defoliation near harvest was made. None of the orchards had any defoliation due to rust including the non-treated. The orchard monitored the longest due to a delayed harvest, had no defoliation by harvest time (See Fig. 11).

Fig. 11.



Conclusion:
Monitoring for prune rust is fairly simple; it takes one person less than 30 minutes to evaluate an orchard. In 1999, only one orchard had 10 percent defoliation from rust at harvest In that orchard rust was detected five 5 weeks before harvest. This year no pre-harvest defoliation from rust occurred even if detected six weeks earlier. This suggests rust monitoring and treatment can be eliminated 4-6 weeks prior to harvest. In 2001 we will evaluate eliminating rust treatments four weeks before harvest. This monitoring technique has the potential of greatly reducing the amount of rust treatments. Thirty three percent of all orchards monitored this year had no rust and did not need a rust treatment. Had prune growers followed this rust monitoring program in 2000 it would have saved the industry $1,560,000 and 528,000 pounds of pesticides (primarily sulfur) in unneeded preventative prune rust applications.

G. Presence–Absence Sequential Sampling for Web-spinning Mites:

Situation:

Prunes occasionally get damage from web-spinning mites and require an in-season treatment. There are no established treatment thresholds for web-spinning mites in prunes and Pest Control Advisors use a subjective judgment when determining need for a mite treatment. When growers make their own treatment decisions it is generally based on visible damage, which is often too late, or on calendar spraying which is often too early or unneeded. A presence-absence web-spinning mite monitoring technique exists for almonds. This technique is being evaluated for prunes.

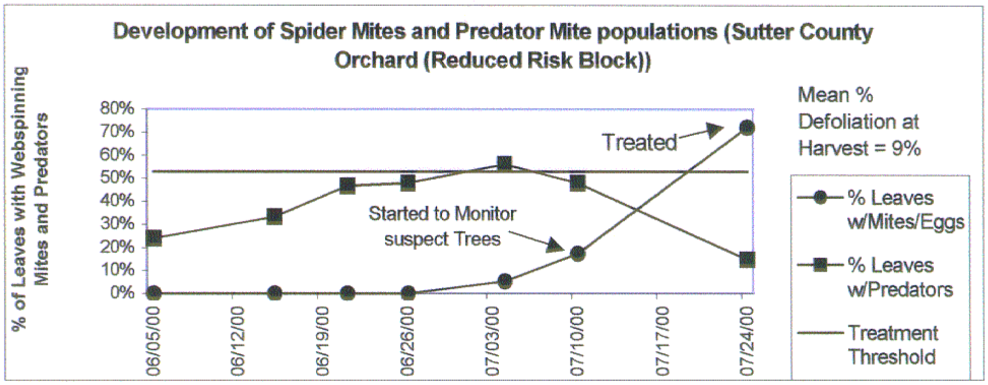
Demonstration:

The presence-absence sequential sampling evaluated for web-spinning mites in prunes consists of sampling 15 leaves from five trees per plot in each block for presence of web-spinning and beneficial mites beginning June 1 and continuing for 10 weeks. Treatment is recommended when a threshold over 53 percent of leaves with web-spinning mites/eggs and predacious mites are present or 32 percent of the leaves have web-spinning mites/eggs and no predators are present. Sampling takes 30 – 45 minutes and is done every other week until 20 percent of the leaves have mites. Once this level is reached sampling is done weekly.

Evaluation:

Monitoring showed a progressive buildup of mites and decline of predators (See Fig. 12). Sixty-one percent of the comparison sites and 36 percent of the demonstration orchards were over the treatment threshold. Seven out of eight comparison sites were treated for mites. Four out of eight comparison sites had some defoliation at harvest; average percent defoliation was 2.42. Two out of four demonstration orchards exceeded the treatment threshold and had some defoliation at harvest. Two of the Demonstration sites did not exceed the threshold and also had some defoliation at harvest. Average defoliation of trees with mites was 3%. Soluble solids were measured on fruit from trees with mite defoliation and compared with that from fruit on trees with no defoliation. No statistical difference was measured between fruit from defoliated or non-defoliated trees (data not shown). There was no statistical difference in web-spinning mite or mite predator populations in the Reduced Risk, conventional, and check plots for the 13 Comparison sites.

Fig. 12.



Conclusion:
Midway through the season it was realized that by using random tree selection for monitoring, trees with mites might be overlooked unless the sample size was significantly enlarged. To correct this problem, monitoring was done by selecting five suspect trees. This new technique was faster and increased one's ability to detect trees with mites (See Fig. 12). With an average of only three- percent defoliation and no measurable difference in fruit soluble solids, 53 percent infested leaves may be a correct treatment threshold for prunes. By implementing this new monitoring technique from the season's start, it should reduce the number of orchards with defoliation. Further validation of the treatment threshold will take place by observing more orchards with or without mites and defoliation. Although this monitoring technique takes too long for Pest Control Advisors to implement, presence-absence monitoring for mites is a useful method of determining need for treatment and reduces the likelihood of treating without justification.

H. Using Leaf Tissue and Water Sample Analyses

Situation:
Although leaf tissue analysis has been recommended for many years, it is an underutilized tool in determining prune tree fertilization needs. Further, some wells contain significant Nitrate Nitrogen, which could be used by growers to offset a portion of the supplemental nitrogen fertilization program. For adoption, these monitoring tools need to be documented and demonstrated to growers.

Demonstration:
Plant tissue and water samples for each site were collected in July. Results from the samples are reported to growers for their consideration making fertilizer application decisions.

Evaluation:

Results of water and tissue analyses are shown in Tables 8 and 9. Sites highlighted in Table 8 have high Nitrate Nitrogen in the water. One orchard (Harkey, Butte) is receiving 28 pounds of nitrogen for every acre-foot of water that is applied during irrigation. Water analyses also found that three of the sites had slightly high salinity levels, and 9 sites had low EC water. If water has a low EC (below. 5 mmhos/cm) permeability problems may develop in the soil. One site (RBF, Tehama) had slightly high levels of Boron, Chloride, and Sodium.

Elements of major concern in prune culture include Nitrogen, Potassium, Zinc, and Boron. Amounts of Nitrogen, Phosphorus, Potassium, Sulfur, Zinc and Boron were obtained through tissue analyses. Three sites were deficient in Nitrogen, one site was slightly deficient in Potassium, 10 sites were slightly deficient in Zinc, and one site had a high level of Boron. Sites highlighted in Table 9 indicate nutrient deficiencies or, in one case (RBF, Tehama), Boron excess.

Table 8. 2000 Water Analyses (I DON'T SEE THE HIGHLIGHTED ORCHARDS)

Grower	pH	EC mmhos /cm	Ca meq /L	Mg meq /L	Na Meq /L	SAR	Cl Meq /L	B ppm	NO3-N ppm	Pounds Of N Per Acre ft of water
Br - Madera(r.r.)	7.2	0.28	1.1	0.6	1	1	0.5	<.1	2.73	7.371
Ag - Tulare(north)	7.4	0.28	1.2	0.1	1.4	2	0.1	<.1	2.25	6.075
Ag - Tulare(south)	6. 9	0.65	4.1	1	1.8	1	0.3	0.1	10.08	27.216
W.G. - Glenn (r.r.)	7.1	0.5	2.5	2.2	1.1	1	0.6	0.2	2.09	5.643
Mo - Tehama (r.r.)	7.3	0.17			0.5		<.1	0.2	<.05	<.135
R.B.F. - Tehama (r.r.)	7.9	0.66			4.1		3.1	1.6	2.72	7.344
CSU - Butte	6.7	0.26	1.2	1.3	0.4	<1	<.1	<.1	3.15	8.505
D.C. - Sutter/Butte	7	0.25	0.8	1.4	0.6	1	<.1	<.1	1.04	2.808
Harkey - Butte	6.8	0.68	2.6	4.6	1	1	0.2	<.1	10.42	28.134
J.H. - Sutter	7	0.35	1	1.6	0.8	1	0.2	0.1	3.36	9.072
B.J. (Clan) - Butte	7.1	0.09	0.4	0.2	0.1	<1	0.7	<.1	<.05	<.135
G.C. - Sutter	7	0.08	0.4	0.2	0.1	<1	<.1	<.1	<.05	<.135
D.B. - Butte	6.4	0.44	1.6	2.8	0.6	<1	0.2	<.1	5.21	14.067
D.E. - Tehama	6.6	0.53	1	1.3	0.9	1	0.1	<.1	1.65	4.455
K.L. - Butte	6.8	0.51	1.7	1.5	2.4	2	0.6	0.2	1.53	4.131
M.K. - Yuba	6.6	0.58	2.7	3.1	1.1	1	0.3	<.1	2.6	7.02
K.J. Yuba	6.9	0.68	2.8	4	1.4	1	0.5	<.1	1.6	4.32
M. B. - Glenn	7	0.81	4.7	3.2	1.5	1	1.1	0.2	8.3	22.41
J.T. – Yolo	7.7	.98	3.3	5.1	2.2	1	1.7	.4	6.1	16.47
M.J. - Sutter	6.8	0.77	2.8	4.8	1.1	1	0.7	<.1	8.51	22.977

r.r. = Reduced risk sites

Table 9. 2000 Tissue Analyses for Various Nutrients 1/ (I DON'T SEE HIGHLIGHTED ORCHARDS)

Grower/Orchard - County	N-Total %	P-TOT %	K-TOT %	S-TOT ppm	B ppm	Zn ppm
D.E. - Tehama	3.025	0.32	3.97	3910	51	23
K.L.- Butte	2.655	0.27	2.72	4960	61	24
JR. T. - Sutter	2.720	0.30	2.75	2280	47	20
J.H. - Sutter	2.356	0.20	2.48	2540	50	13
Ons - Butte	2.534	0.35	3.10	1780	58	19
B.J.(clan) - Butte	2.581	0.27	2.28	2210	44	21
M.K. - Yuba	2.312	0.13	1.64	2530	31	14
G.C. - Sutter	1.943	0.13	1.77	1830	33	13
K.J. - (Reduced Risk)	2.443	0.12	1.20	2050	35	23
K.J. - (conv.)	2.458	0.11	1.23	2070	34	19
M.B. - Glenn	1.930	0.15	1.91	1820	47	17
D.B. - Butte	2.320	0.16	1.85	2310	46	14
CSU (Reduced Risk) - Butte	2.582	0.21	2.09	2790	49	17
CSU (conv.) - Butte	2.601	0.29	2.65	3540	52	19
Harkey (Reduced Risk) - Butte	2.459	0.26	1.81	1920	40	13
Harkey (Conv.) - Butte	2.250	0.26	1.93	2040	39	12
M.J. (conv.) - Sutter	2.429	0.19	1.58	2080	43	11
M.J.(Reduced Risk) - Sutter	2.262	0.19	1.80	1990	37	13
D.C.(Reduced Risk) - Sutter	2.424	0.14	1.41	2140	37	14
D.C.(conv.) - Sutter	2.124	0.13	1.38	2010	38	13
V.D. - Tehama	2.578	0.34	3.86	2760	80	13
Mo. - Tehama	2.821	0.33	3.62	2350	81	16
R.B.F. - Tehama	2.514	0.46	4.00	2130	111	203
Br. - Madera	2.417	0.49	3.82		76	30
Ak (Con) - Fresno	2.805	0.27	3.40		81	137
Ak (Reduced Risk) - Fresno	2.370	0.34	3.87		87	185
DA (Conv) - Tulare	2.617	0.26	2.97		84	73
DA (Reduced Risk) - Tulare	2.744	0.26	3.15		70	69
DA (Check) - Tulare	2.636	0.20	2.48		67	30
J. T. (Reduced Risk) - Yolo	2.561		2.23		53	57
J. T. (conv) - Yolo	2.885		2.23		55	62
W.G. (Reduced Risk) - Glenn	2.239		2.75		47	25
W.G. (Conv) - Glenn	2.405		2.95		50	309
W.G. (Check) - Glenn	2.136		2.77		49	18
T.B. (Conv) - Merced	2.612		2.33		52	9
T.B. (Reduced Risk) - Merced	2.390		2.60		52	13
Gr.(Reduced Risk) - Merced	2.630		2.12		66	12
Gr.(Conv) - Merced	2.737		1.76		56	13

1/ Deficient levels of the nutrients are as follows: Nitrogen – less than 2.2 percent; Potassium – less than 1.3 percent; Zinc – less than 18 ppm; and Boron – less than 30 ppm. Boron is also toxic at levels above 100 ppm.

University of California Cooperative Extension advisors involved at these sites will be working with their cooperators on fertilizer recommendations based on these analyses. Water samples did indicate several wells with significant levels of nitrate Nitrogen in the water. Nitrate levels in the water will be considered when making fertilizer recommendations. These tissue and water analyses have provided useful information for growers proving their potential utility for optimizing or reducing fertilizer inputs.

I. Irrigation Management

Situation:
Irrigation management in this project is based on previous research showing that stress can be accurately determined by measuring midday stem water potential. Economic prune production appears to tolerate mild to moderate water stress later in the season when dry yield is not affected and fruit hydration ratio is improved. Additional beneficial effects may also occur in prune (reduction in excess vegetative growth, increased return bloom), but these have been more difficult to clearly identify. Reduced water input is one of the important goals of this project. Knowledge of such tree response to stress may save irrigation without causing detrimental effects on yield or fruit quality.

Demonstration:
In the morning, a plastic/foil envelope was used to cover a lower canopy leaf close to the trunk or a main scaffold. The recommended time between covering and measuring tree-water status in the pressure chamber has been 2 h, but in 2000, additional tests were performed to determine the minimum time required. The recommended measuring time is midday (between 1:00 PM and 3:00 PM), at peak evaporative demand. Leaves remained covered during the entire sampling and measurement procedure. Measurement of tree –water status was made using a pressure chamber device. In most cases, 10 trees per orchard were monitored weekly for tree water status. The cooperator was advised of the readings and when appropriate, the reduced risk plot was irrigated; the grower irrigated the conventional side as he/she saw fit.
For fully irrigated prune trees, the value of midday stem water potential will depend on temperature and relative humidity (see Table 10). For this project, however, a deficit irrigation strategy was recommended using the irrigation threshold values indicated in Table 11.

Table 10. Values of midday stem water potential (in Bars) to expect for fully irrigated prune trees, under different conditions of air temperature and relative humidity.

Temperature (EF)	Air Relative Humidity (RH, %)						
	10	20	30	40	50	60	70
70	-6.8	-6.5	-6.2	-5.9	-5.6	-5.3	-5.0
75	-7.3	-7.0	-6.6	-6.2	-5.9	-5.5	-5.2
80	-7.9	-7.5	-7.0	-6.6	-6.2	-5.8	-5.4
85	-8.5	-8.1	-7.6	-7.1	-6.6	-6.1	-5.6
90	-9.3	-8.7	-8.2	-7.6	-7.0	-6.4	-5.8
95	-10.2	-9.5	-8.8	-8.2	-7.5	-6.8	-6.1
100	-11.2	-10.4	-9.6	-8.8	-8.0	-7.2	-6.5
105	-12.3	-11.4	-10.5	-9.6	-8.7	-7.8	-6.8
110	-13.6	-12.6	-11.5	-10.4	-9.4	-8.3	-7.3
115	-15.1	-13.9	-12.6	-11.4	-10.2	-9.0	-7.8

Table 11. Irrigation threshold values for midday stem water potential (bars) during the growing season for in prunes.

Period	Month						
	March	April	May	June	July	August	September
Early-	-6	-8	-9	-10	-12	-13	-14
Mid-	-7	-8	-9	-11	-12	-13	-15
Late-	-7	-9	-10	-11	-12	-14	-15

Evaluation and Conclusions:

At the CSU-Butte county site, a comparison was made between conventional and reduced-risk irrigation management. There was a substantial savings in applied water during the 2000 season (See Fig. 13).

By season's end in this orchard, a total of 340 mm water was applied to the reduced-risk block, compared to 600 mm applied to the conventional block, a savings of over 40% with no apparent loss in production or quality. This is a particularly notable savings because the conventional block was already being irrigated conservatively, receiving slightly less water than would be estimated by DWR recommended weather-based methods (California Irrigation Management and Information Systems, CIMIS). The most conservative CIMIS estimate of crop water use would be for a clean cultivated orchard (no water use by a cover crop), and based on a 100% application efficiency (no runoff or deep percolation). For this location and those circumstances the weather-based model would have recommended 800 mm of irrigation during the 2000 season. For a full cover crop orchard, this figure would be 1150 mm. Hence, the reduced-risk irrigation management provided a significant water savings (57% - 70%), even based on conservative estimates of crop water demand (100% efficiency values). This highlights value of plant-based monitoring for irrigation management, because this approach takes into account the trees ability, when under moderate stress, to use stored soil water to supply a substantial fraction of it's water requirements. The levels of stress that occurred in the reduced-risk trees were consistent with the threshold values established for prune (see Fig. 14), and only represented a moderate level of stress by season's end. In early to mid-August degree of water stress in the reduced-risk and conventional treatments were quite similar, further demonstrating that the reduced-risk protocol does not involve unreasonable levels of stress. It is also possible that the withholding of water in 1999 and 2000 has encouraged deeper rooting in these trees and has improved the trees ability to obtain stored soil water reserves. It should be pointed out that this is but one of the 33 orchards monitored in 2000 and not all the orchards saved this much water. It does point out the potential savings under this situation.

Fig. 13: Orchard water demand (ET) based on CIMIS weather data, compared to water applied in conventional and reduced risk blocks.

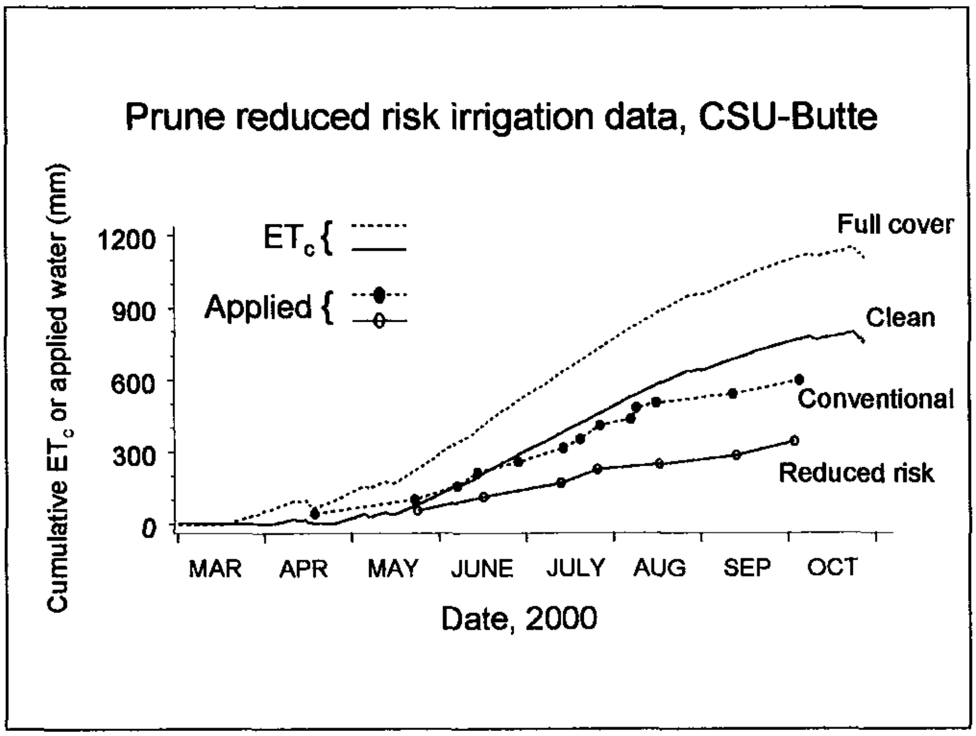
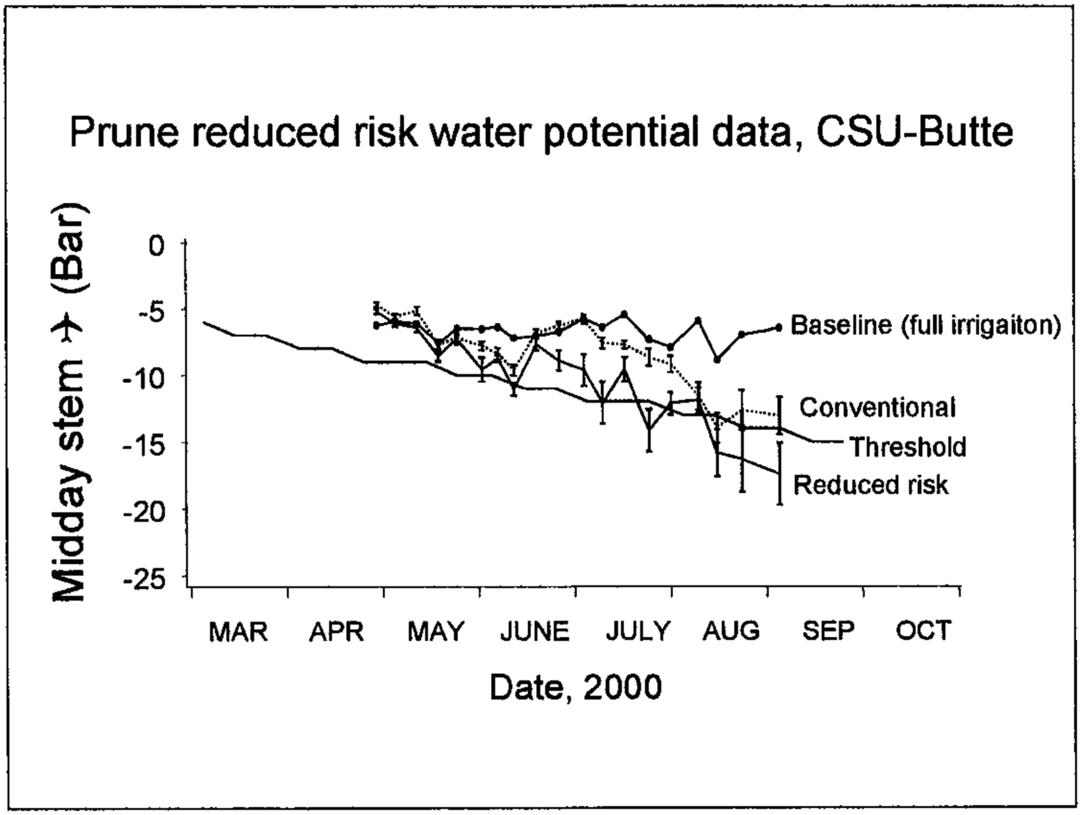


Fig. 14: Midday stem water potential in conventional and reduced risk plots, compared to fully irrigated baseline values and recommended irrigation threshold values.



Because of increasing interest by prune growers and irrigation consultants in our plant-based monitoring approach, nine separate studies were performed during August/September in Tehama County to determine the minimum time necessary between placing the bag on the leaf and measuring it in the pressure chamber. Results showed there was a very large effect if the bag was omitted entirely (See Fig. 15, duration = 0), but that after about 10 minutes of bagging duration there was very little change in water potential. This result is a substantial and practical improvement for our plant-based monitoring technique, because a shorter time between bagging and measuring allows for much more flexibility in scheduling orchard monitoring. This will make the technique much more likely to be adopted by growers, advisors and consultants. On a number of occasions in the DC-Sutter county plot, comparisons were made between the standard bag duration and either immediate, 2-3 minutes or >10 minutes duration. These data were analyzed using regression techniques (See Fig. 16), and in all cases this analysis showed that there was a reasonable correlation to the standard.

Fig. 15. Test of bagging duration on the agreement between test and reference leaf water potential. (WHAT IS MPA – I.E. FOR THE READER)

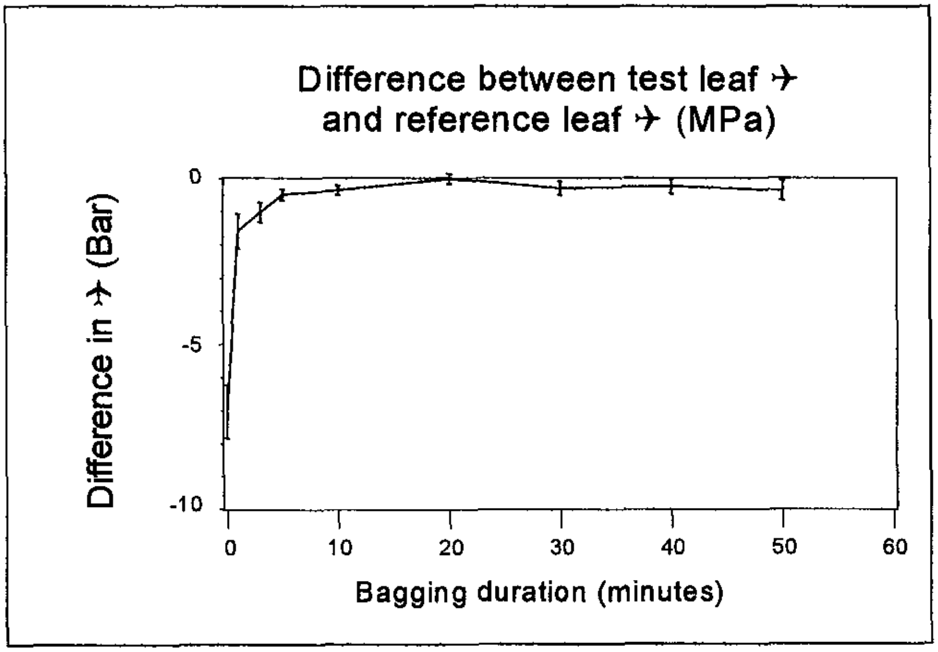
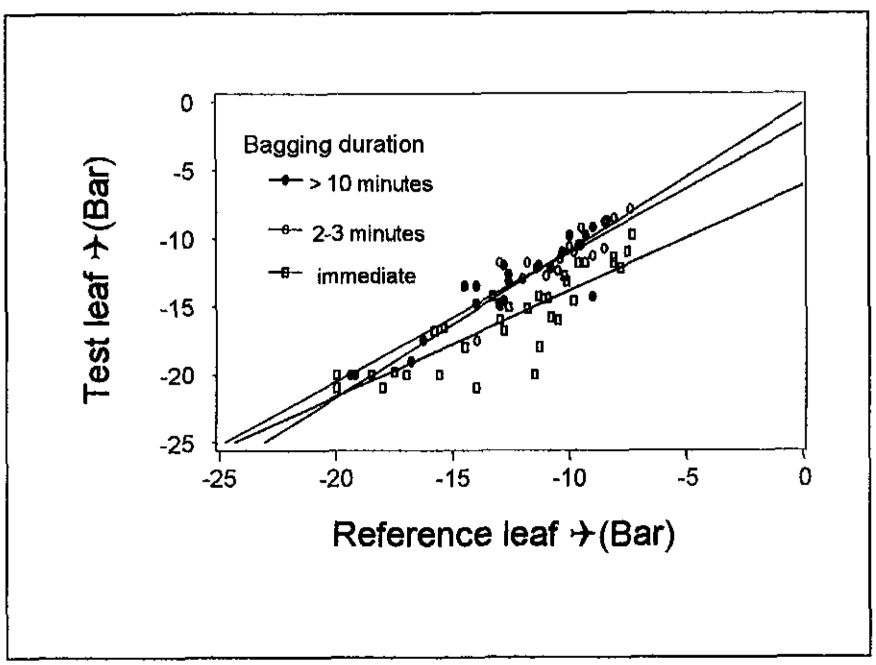
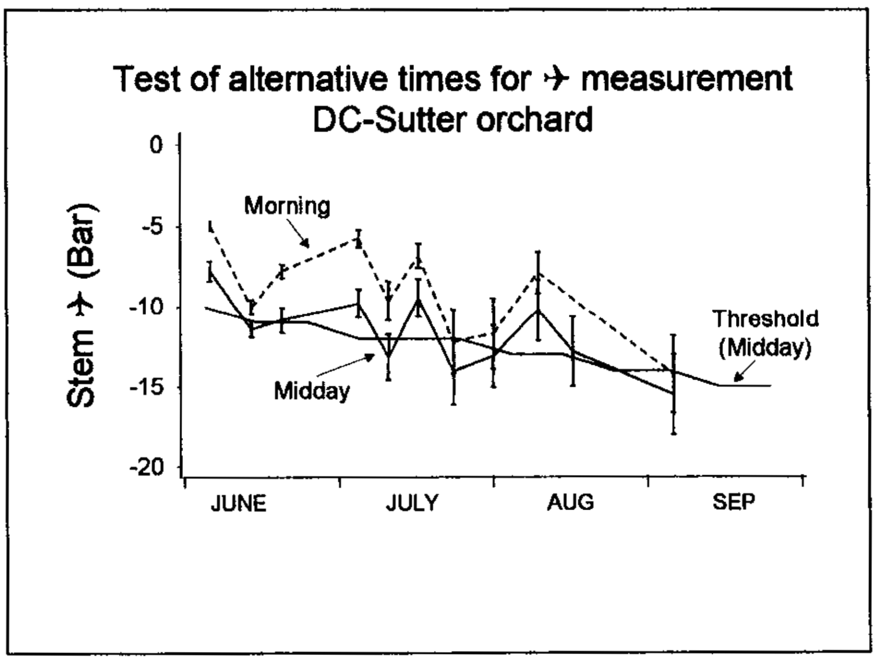


Fig. 16. Agreement between standard and test leaf water potential for different choices of bagging duration.



In the case of 2-3 minutes and >10 minutes, the regression equation was not significantly different from a 1:1 relation, but for measurements immediately following bagging this was not the case. It is interesting to note, however, that moderate to severe stress (around -20 bars) all values were similar. This is to be expected, because leaf water loss is reduced by stomatal closure as stress becomes severe, and closure of stomata should essentially mimic the effects of the plastic bag. This result is interesting because it indicates that no pre-bagging would be necessary to correctly evaluate severe stress in prunes. An additional study was performed at the DC-Sutter county plot in which mid-morning measurements were made around 10:00, in addition to the standard midday measurements. These results (See Fig. 17) showed that both times of day exhibited more-or-less parallel changes in stem water potential throughout the season. This indicates that it may be possible to extend the period of sampling beyond the currently recommended midday period (1:00 - 3:00 PM), if further research can establish appropriate irrigation thresholds for different periods of the day.

Fig 17: Comparison of standard midday measurements of water potential to morning measurements. Also shown for reference is the recommended irrigation threshold.



J. Fruit Brown Rot Predictive Model

Situation:

There is no current way of knowing if fruit brown rot will occur late in the season. Consequently growers have been spraying prophylactly for fruit brown rot based on a suspicion that it will occur. Applications for late season brown rot are not applied in any one year by most prune growers but are applied where a history of problems with brown rot in an area exists. UC Plant Pathologist Themis Michailides has created an in-season technique to determine the presence of fruit brown rot that needs to be validated. The technique is called Over Night Freezing Technique (ONFIT).

Demonstration:
ONFIT involves freezing a sample of green fruit in early June to reveal latent infections by *Monilinia fruticola* or *Monilinia laxa*. Levels of latent infection revealed using the ONFIT model are correlated to levels of fruit brown rot infections that will become visible later in the season and post harvest. This information is used to determine need to protect fruit from brown rot infection with a pre-harvest fungicide application.

Evaluation:
Results of the ONFIT procedure predicted that 3 of 13 Comparison sites and 2 of 11 Demonstration sites had low levels of latent brown rot present. No fungicide treatments for fruit brown rot were recommended for any of the Comparison Sites or Demonstration Sites based on the ONFIT fruit brown rot predictive model. At harvest, 1000 fruit per block were examined for presence of brown rot infection. Final field evaluations just prior to harvest indicted that fruit brown rot was present in low levels at 6 of 13 Comparison sites and 4 of 11 Demonstration sites. Brown rot levels at harvest only exceeded 1% infected fruit at one of the sites see Table 12.

Table 12.

	% Infected Fruit or Clusters of Fruit			
County and Site	**ONFIT Prediction**	**Brown Rot Present at Harvest**		
	Reduced Risk	Reduced Risk	Conventional	Check
Sutter - MJ	0.00%	0.00%	0.00%	0.10%
Yuba - MK	0.00%	0.00%	0.00%	0.00%
Yuba - KJ	0.00%	0.30%	0.10%	0.00%
Sutter - GC	0.00%	0.10%		
Sutter - JH	0.00%	0.10%		
Butte - BJ(clan)	0.00%	0.00%		
Butte - Harkey	0.00%	0.00%	0.00%	0.00%
Sutter - DC	0.00%	0.10%	0.00%	0.00%
Butte - CSUC	0.00%	0.20%	0.00%	0.30%
Butte - DB	0.00%	0.10%		
Glenn - WG	0.00%	0.10%	0.00%	0.00%
Tehema - D.E.	0.00%	0.00%		
Tehema - R.B.F.	0.00%	0.00%	0.00%	0.00%
Tehema - Mo	1.00%	0.00%	0.00%	0.00%
Tehema - V.D.	0.00%	0.00%	0.00%	0.00%
Butte - Ons	3.00%	0.10%	0.00%	0.10%
Butte - K.L.	2.00%	0.00%		
Madera - Br	0.00%	0.00%	0.00%	0.00%
Fresno - Ak	0.00%	0.00%	0.00%	0.00%
Tulare - Ag	0.00%	0.00%	0.00%	0.00%
Sutter - JR.T.	1.00%	0.10%		

Glenn - M.B.	1.00%	1.70%	0.10%	0.40%
T.B. - Merced	0.00%	0.00%	0.00%	0.00%
Yolo - JT	0.00%	0.00%	0.00%	0.00%

Conclusion:
ONFIT needs to be evaluated under more severe conditions before it can be relied upon. Under current conditions of little or no fruit brown rot, ONFIT accurately predicted no fruit brown rot. Although fruit brown rot is not routinely sprayed for, this monitoring technique could provide valuable guidance for a fruit brown rot spray.

K. Yield and Quality Evaluation from P-1 Grade Sheets:

Grower/cooperators were asked to provide P-1 grade sheets and weight receipts from Conventional and Reduced Risk blocks of the comparison sites. The grower/cooperators of the Demonstration orchards were also asked to provide P-1's Grade sheet information for the 2000 crop year was not received in time to be used in this report. The 1999 grade sheet data (see Table 13) indicated no significant difference in yield; dry away, % ABC screen fruit, or % ABC screen offgrade fruit, between the Conventional and Reduced Risk sites. However the Reduced Risk blocks did have significantly larger fruit (count per pound) than did the Conventional blocks. Based on data obtained from the 1999 P-1 grade sheets, no adverse affects were seen in the Reduced Risk program as compared to the Conventional program.

Table 13: 1999 P-1 Grade Sheet Analysis

1999 P-1 Grade Sheet Analysis					
	Yield (lbs/acre)	Average Count per Pound	Dry Away	% ABC screen	% ABC Offgrade screen
Reduced Risk	4705	52.5 B	2.79	91.4	2.21
Conventional	4387	54.75 A	2.77	90.1	1.13

L. Pest Control Advisor Involvement in Project:

Eleven Pest Control Advisors (PCAs) were asked to review and, if possible, try using the monitoring techniques under evaluation during the 2000 season. At a meeting held in October 2000, PCA's and the project team met and discussed the monitoring techniques. Following are highlight points made at that meeting:

1) Many of monitoring techniques took too long to implement. Many PCA's reported they could not spend more than one-hour per week in an orchard. One PCA said he could not spend more than 30 minutes in an orchard. Suggestions made to speed up the monitoring procedure included: using a timed search rather than looking at a certain number of trees, look at one side of tree only rather than walking around tree, rather than recording data just keep a mental note of abundance of the pest being monitored.
2) Several PCA's reported they use a more subjective monitoring technique. The quantitative monitoring under evaluation takes too long.

3) The PCA's all agreed that the treatment thresholds were about right and about the same they had been using.
4) Most PCA's found that dormant spur sampling was useful and even though it took some time, winter is when they have more time and it required monitoring only once per season.
5) The PCA's found that tree and fruit monitoring were useful but agreed that it took too long and too many trees had to be looked at before a decision could be made.
6) PCA's felt that spring time aphid monitoring was useful but preferred quickly covering the entire orchard rather than the quantitative approach as stated in the monitoring protocol.
7) PCA's found that pheromone traps provided little if any useful information and recommended discontinuing their use.

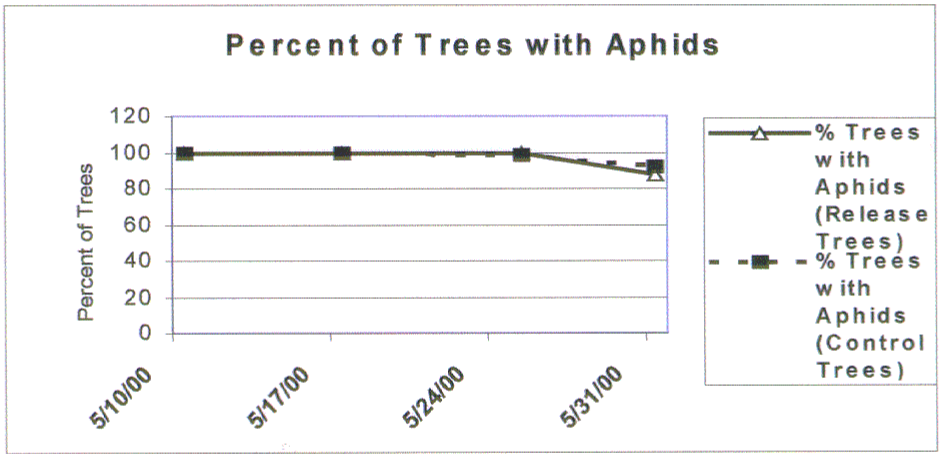
Overall, PCA's were pleased to be involved in the project. As stated in the highlighted meeting points, PCA' s favor more subjective methods of monitoring. However, for this project, quantitative methods must be used in order to determine what treatment threshold and/or monitoring techniques are most accurate. When techniques and thresholds are finally presented to all involved in the prune industry, it is understood many will use subjective techniques and shortcuts in order to save time and money. Most PCA's at the meeting agreed to continue being involved next year.

M. Satellite Projects:

Efficacy Trial of Using *Harmonia axyridis* Lady Bird Beetles to control Mealy Plum Aphids on Prunes

An orchard in Sutter County was chosen as a trial site due to the great amount of MPA infestation occurring there. Finding different control methods for Mealy Plum Aphid has become a priority, since the pesticide most commonly used for treatment, Diazinon is in danger of being phased out. Lady bird beetles are natural predators of aphids and the *Harmonia axyridis* is known for being an especially fierce predator. Five Hundred *Harmonia axyridis* lady beetles were distributed throughout a 1-acre block (5 per tree). Every tree where beetles were released had MPA. Fifty predator release trees were marked and used to evaluate aphid control by *Harmonia axyridis* and 50 non-predator release trees were also monitored for aphid control. Monitoring took place weekly for three weeks after the initial release of beetles. The amount of *Harmonia axyridis* adults, larvae, and eggs found on each tree was recorded. Also, each tree was evaluated for presence of aphids. Trial results showed lady beetles had no significant effect on controlling the MPA population (See Fig. 20).

Fig. 20.



Satellite Project: Pesticide Efficacy Trial on Mealy Plum Aphid

This trial was set up to determine efficacy of using oil compared to an insecticide for control of mealy plum aphids during the season. It was conducted in a prune orchard in Sutter County that had an existing MPA population. Branches with heavy aphid populations were marked and used for the trial. The trial was set up using 4 treatments, including an untreated, with 4 single tree repetitions per treatment. The trial was a randomized complete block design. The three treatments used included: 1) insecticide (Asana @ 6oz/acre + 4oz of Breakthru/acre) and 2) oils (Gavicide oil @ 6 gal/acre + 4 oz. Breakthru/acre, and 3) Stylet oil @ 2 gal/ acre + 4oz. Breakthru/acre). The treatments were applied using an air blast backpack sprayer in order to simulate a commonly used air blast orchard sprayer. Two different rates of application were used. Treatments were applied at 100 GPA at 1.5 mph and at 200 GPA at 0.75 mph. Evaluations were made one day after application and then again six days after the application. Trees were rated for aphid control using the following rating: 1) = complete control, 3) = partial control, and 5) = no control. Trial results found all 3 treatments were effective in controlling in-season MPA on prune trees at the higher application rate of 200 GPA at 0.75 mph (See Table 16). Results also proved that 1 day after application was to soon to make an accurate evaluation.

Table 16.

Mealy Plum Aphid Efficacy Trial			
Efficacy 1 Day after Treatment		**Efficacy 1 Day after Treatment**	
100 GPA at 1.5 mph		**200 GPA at 0.75 mph**	
Asana	2.75 B	Asana	1.5 BC
Gavicide oil	2.5 B	Gavicide oil	2.0 BC
Stylet oil	4.5 A	Stylet oil	2.0 BC
Untreated	5.0 A	Untreated	5.0 A
Efficacy 6 Day after Treatment		**Efficacy 6 Day after Treatment**	
100 GPA at 1.5 mph		**200 GPA at 0.75 mph**	
Asana	1.5 B	**Asana**	**1.0 C**
Gavicide oil	2.0 BC	**Gavicide oil**	**1.0 C**
Stylet oil	3.25 AB	**Stylet oil**	**1.0 C**
Untreated	5.0 A	Untreated	5.0 A

Treatment means not followed by a common letter are significantly different at the 5 % level according to Duncan's Multiple Range Test for Mean Separation.

Satellite Project: Alternate Year Dormant Insecticide Spray Program in the Sacramento Valley

The alternate year dormant spray strategy was initiated and developed in the San Joaquin Valley prune district. The rationale was that when excellent control of SJS, PTB, and ERM was accomplished one dormant season, insufficient recovery would occur the second dormant season to cause economic damage the second season. Indeed, costs and pesticide use is halved with such a strategy. Prune aphids, however are not a general problem in the San Joaquin Valley meaning this approach has utility there. In recent years growers have tried to go to an alternate year dormant insecticide spray program in the Sacramento Valley to save money, help the environment, and try and continue to have a larger population of natural enemies present. The hazard of an alternate year dormant spray program there is control of mealy plum and leaf curl plum aphids. Some growers have reported having to apply an in-season treatment for aphids due to the lack of a dormant spray.

Other growers have reported little or no aphid problem when comparing a dormant spray year to a non-dormant spray year.

To see if there would be an aphid problem by adopting an alternate year dormant spray program in the Sacramento Valley, six orchards that had received a dormant spray and were evaluated for aphids in 1999 did not receive a dormant spray and were evaluated for aphids in 2000. Three of the orchards were in Sutter County, two of the orchards were in Yuba County, and one orchard was in Tehama County. Aphid counts from the 1999 growing season were compared to aphid counts taken during the 2000 growing season. The data comparison indicated aphid populations in the orchards were significantly higher in the 2000 growing season when compared to the 1999 growing season (see Table17). Four of the six orchards had a significant aphid problem by not applying a dormant spray, two had a moderate problem and one grower had no increase in aphids.

Table 17: Alternate Year Dormant Insecticide Spray Treatment Results

	Block with Dormant Spray		Block Without Dormant Spray	
	1999		2000	
	LCPA	MPA	LCPA	MPA
D.C. - Sutter	0.00%	0.00%	15.00%	3.75%
J.H. - Sutter	0.00%	2.50%	5.00%	100.00%
K.J. - Yuba	0.00%	0.00%	0.00%	0.00%
M.K. - Yuba	0.00%	0.00%	13.75%	17.50%
J.R. - Sutter	0.00%	2.50%	0.00%	30.00%
D.E. - Tehema	1.25%	0.00%	85.00%	0.00%
Average	**0.21%**	**0.83%**	**19.79%**	**25.21%**
Average Increase from 99 to 2000:			**9500%**	**3025%**

The aphid population increased dramatically when a dormant insecticide was used. Presumably the increase in aphids was due to the lack of natural enemies that had been killed along with the aphids. These data indicate an alternate year dormant insecticide spray program may not be a good program for many Sacramento Valley Growers due to problems created by one or both aphids. The dormant spray controls both.

N. Outreach and Extension

Meetings to share information were numerous and well attended. Each participant advisor held one or more educational meeting that discussed the IPFP, Reduced Risk project; over 1100 people attended Following is a list of meetings held, dates, and subjects covered

County	Date(s)	Subjects Covered
Butte/ **Sutter**	10-12-99, 5-4-00, 2-22-00, 6-28-00 10-8-99, 5-12-00, 5-26-00	Cover Crops, reduce inputs for insect control, River Contamination, Prune Aphids, Reduced Risk overview
Colusa	4-27-00	Cover Crops
Glenn	11-15-99, 4-20-00, 6-16-00 4-20-00	Vegetation to reduce dormant spray runoff, Cover Crops, Prune Aphids
Merced	3-15, 4-5, 4-19, 5-3, 5-17 6-7, 6-21, 7-5-00	IPM updates
Tehama	10-6-99, 3-7-00,5-10-00	Cover crop planting, Reduced Risk overview
Tulare	(SJV PRUNE DAY TOO) 6-13-00	Reduced Risk overview

In addition, Tehama, and Glenn County advisors provided insect day degree accumulation to clientele via e-mail or web site on a regular basis. Advisors wrote several newsletters and two popular articles were published. The IPFP Newsletter was published four times in 2000.

O. Documentation and evaluation:

Pesticide Usage Survey and Pesticide Use Reporting:

Ten Butte County growers farming 3,500 of prunes were interviewed to see what changes have taken place in their pesticide usage over the past 5 years. All ten growers have used an annual dormant insecticide and oil treatment to control peach twig borer, San Jose Scale, European Red Mite, mealy plum aphid and leaf curl plum aphid. Many have experimented with not using a dormant insecticide spray program but most continue to use either an organophosphate or pyrethroid spray during the dormant season on much of their acreage because of the likelihood of aphid problems when a dormant spray is not used. Many growers interviewed explained that their spray programs consist of every other row spraying with reduced rates of materials. Table 14 shows the dormant programs used and table 15 show the percentage of acres treated for various pests during the growing season.

In order to see if the results of this grower survey were a good representation of the pesticide usage trends on all prunes in California, Pesticide Use Reports were evaluated over the same years that the survey covered. The results of evaluating the Pesticide Use Reports coincide with the results of the grower survey. Figure 18 clearly shows a trend of fewer acres being treated with Diazinon and Supracide, and more acres being treated with Asana. Figure 19 illustrates the total pounds of pesticides (active ingredients) applied to California prune orchards. This graph was included to show that Oils and Sulfur make up the majority of the pounds of pesticides used as reported by the California Department of Pesticide Regulations.

Table 14: Dormant Spray Program of 10 Growers

	Acres Sprayed out of 10 Orchards				% of Acres with	% of Acres with	% of Acres with	
	Total	Diazanon	Supracide/oil	Asana	Diazanon Applied	Supricide/oil Applied	Asana Applied	% Untreated
1995	2620	1075	850	695	41.03%	32.44%	26.53%	0.00%
1996	2620	75	220	1495	2.86%	8.40%	57.06%	31.68%
1997	3195	275	1370	420	8.61%	42.88%	13.15%	35.37%
1998	3195	0	20	1695	0.00%	0.63%	53.05%	46.32%
1999	3500	527	20	1770	15.06%	0.57%	50.57%	33.80%

Table 15: Percent of Acreage Treated During the Growing Season for Various Prune Pests by 10 Growers

Percent of Acerage Treated for Various Prune Pests by 10 Growers						
Pest Treated For	1995	1996	1997	1998	1999	Average
Prune Rust	15	73	95	97	67	69.4
Aphids	3	19	0	8	0	6
Brown Rot	0	32	0	30	3	13
Peach Tig Borer	0	19	13	8	0	8
Webspinning Mites	0	2	0	2	7	2.2

Fig. 18: Percent of Total Prune Acres in California Treated with Various Pesticides

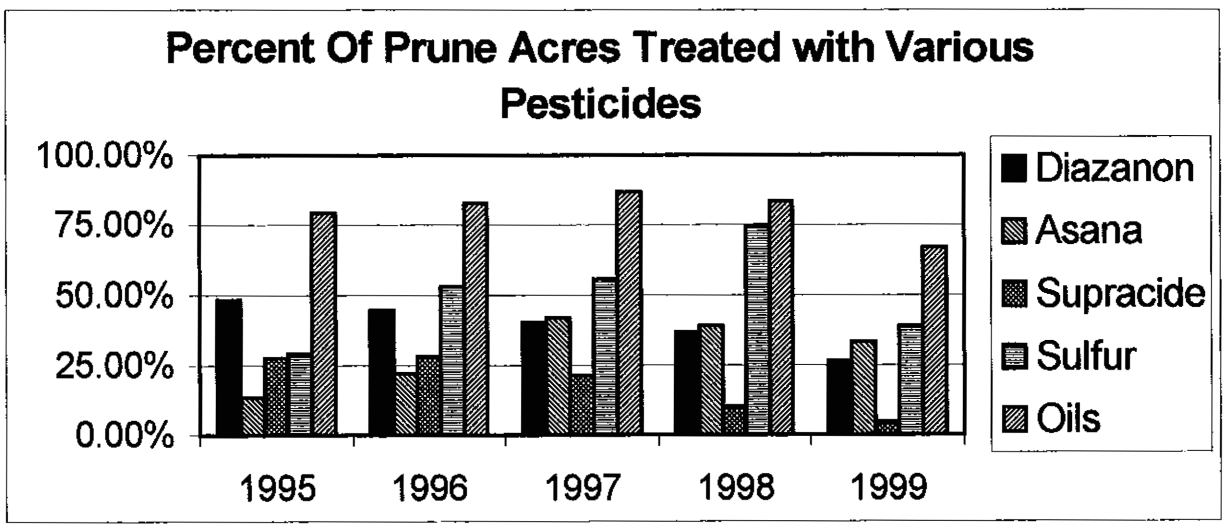
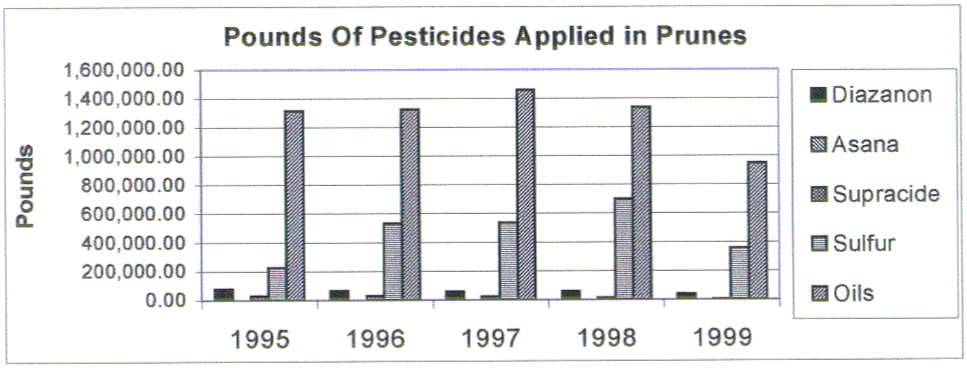
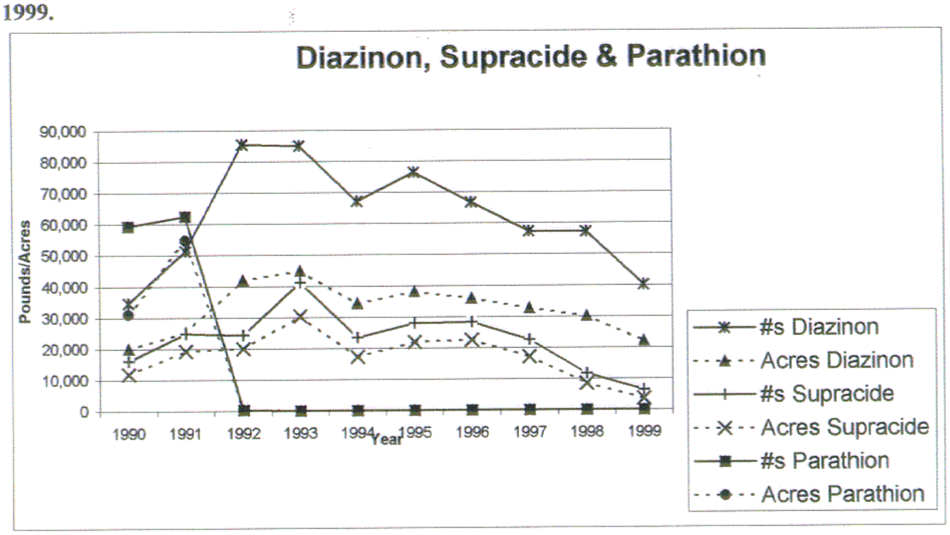


Fig. 19: Total Pounds of Various Pesticides Applied to California Prune Orchards



Diazinon and Supracide peaked in use in the Prune Industry shortly after Parathion was removed from use. Fig. 20 shows the peak in Diazinon use in 1992 at 85,388 pounds and down to 40,116 pounds in 1999. Many things including the efforts of the IPFP Program have influenced this downward trend in use of Diazinon.

Fig. 20: Diazinon, Supracide & Parathion 1990-1999.



This survey indicates a fairly clear trend of less reliance on organophosphates and a shift to more pyrethroid dormant season sprays during the 5 years covered by the interview. During the past 4 years, about 30 percent of the acreage involved in this survey received no dormant spray. During the growing season, prune rust was most frequently treated for with an average of 70 percent of the acreage being treated with sulfur. Aphids and peach twig borer, controlled with dormant insecticide and oil treatments, were rarely treated for during the growing season, as were fruit brown rot and web spinning mites.

Discussion:

The project has progressed well. It will take several years to resolve issues like aphids, Peach Twig Borer, mites, rust, brown rot and etc. and put them into an economic reduced-risk pest management program. The prune industry has an earnest desire to make this project a reality similar to results of the CSREES project.

Each grower cooperator will receive summary data from his farm and we will discuss what it means. Based upon these results we will adjust the IPFP Project, as the Management Team deems necessary. The Management Team is adding more grower sites, more field meetings, and working with PCAs to see if the protocols can be streamed lined for commercial use.

New Directions in the IPFP Program:

- Defoliation of an orchard early in fall will be tested as a control of Prune Aphids.
- Oil applications made in the fall will be tested for aphid control.
- Reduced rates of Diazinon and Asana in a dormant application will be tested for control of aphids.
- Trapping for aphids in the fall will be evaluated as a tool to predict the need for aphid control.
- Pest Control Advisors (PCA's) will continue to be involved in the project by using IPFP monitoring techniques in some demonstration plots.
- Some monitoring protocols will be modified so that they can be conducted faster and made more "PCA friendly."
- Early forecasting of potassium deficiency will be implemented.
- Efforts will be made to improve quality of the IPFP Newsletter, number of meetings and measuring impacts of IPFP Program on prune growers and industry.

V. Appendix

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IPFP
Demonstration /Research Plots
i.e., ESPS, SAREP/BIFS, DPR/PMA, CSREES, NRCS

	County	Project	Grower(PCA)/ Ranch	Plot Size Conv./Reduced Risk/Control	Acres of Prunes Farmed	Total Acres Farmed
1.	Butte	R&D/BIFS	Onstott Orchards	15/14.5/.5	400	890
2.	Butte	D/PMA	Johnson Klan	10	75	100
3.	Butte	R&DESPS	Brad Johnson	4.81/5.23/.5	---	---
4.	Butte	D/BIFS	Dan Bozzo	11	160	173
5.	Butte	PCA/PMA	Hans Gabski/Phil Wilson	6	75	150
6.	Butte	R&D/CSREES	Chico State Farm	20/5.82/.31	45	650
7.	Butte	PCA/BIFS	Tom Dowd/Sohnery Ranch	5	200	1500
8.	Butte	PCA/CSREES	Shawn Copper/Fenn Ranch	40	200	600
9.	Glenn	D/BIFS	Larabee Farms	6	444	1000
10.	Glenn	R&D/BIFS	Billiou Ranches	20/19.1/.9	734	1213
11.	Glenn	R&D/ESPS	Willow Glenn Orchards	9/5/4	513	1750
12.	Glenn	PCA/PMA	Eric Testerman/Toney Orchards	5	60	100
13.	Glenn	PCA/BIFS	Hans Gabski/Neiderholzer	6	66	66
14.	Glenn	PCA/CSREES	Mike Davis/Sycamore Ranch	15	100	200
15.	Tehama	R&D/ESPS	Abby Ranch	9.5/12.3/.5	>22	>22
16.	Tehama	R&D/CSREES	Minch Ranch	5.9/6.2/.3	>12	>12
17.	Tehama	D/PMA	Farmland Management	9.3	694	2879
18.	Tehama	PCA/PMA	Bruce Carroll/Big M Ranch	5	48	150
19.	Tehama	PCA/BIFS	Steve Gruenwald	5	17	30
20.	Sutter	D/BIFS	Thiara Ranches	12	50	250
21.	Sutter	R&D/PMA	David Crane	5.1/5.3/2.9	100	300
22.	Sutter	R&D/ESPS	John Heier	5.13/5.13/1.6	65	200
23.	Sutter	R&D/PMA	Monty Johnson	9.9/9.6/.35	130	150
24.	Sutter	R&D/BIFS	Gary Carlin	9.2/7.4/.83	70	172

25. Sutter	PCA/PMA	Gary Walker	80	1,000	1,000
26. Yuba	D/PMA	Mariana Plant 2	5.1/5.2/.5	380	380
27. Yuba	R&D/CSREES	Kulwant S. Johl	12.95/5.28/.25	530	600
28. Yolo	R&D/BIFS	Joe Turkovich	9/9/<1	112	160
29. Merced	PCA/BIFS	Larry Whitted/Greenleaf	77	600	2500
30. Merced	R&D/PMA	Thiara Brothers Orchards	35/5/<1	641	800
31. Tulare	R&D/ESPS	Dan Aguair	40/20/20	475	980
32. Fresno	R&D/BIFS	Campos Brothers	20/4.5/.5	500	9000
33. Madera	D/PMA	Sherman Thomas Ranch	40/65/1	105	700
		Total	**814.39**	**8,623**	**28,677**

R&D- Research & Demonstration, D- Demonstration only, PCA- Pest Control Advisor, Demonstration only